Domain Specific Language for Geant4 Parallelization for Space-Based Applications, Phase I

Completed Technology Project (2014 - 2014)

Project Introduction

A major limiting factor in HPC growth is the requirement to parallelize codes to leverage emerging architectures, especially as single core performance has plateaued and architectures like short vector units (e.g., AVX), Intel Xeon Phi, and GPUs are embraced by hardware manufactures. The proposed SIMD/SIMT vectorization tools for emerging accelerator-based compute architectures will impact a world-wide range of academic, government, and commercial researchers. The Geant4 toolkit enables the simulations of the passage of particles through matter. As with many scientific codes, it was originally developed for single processor compute nodes using compute clusters, and has not been optimized for SIMD/SIMT architectures (e.g., many-core nodes, GPUs, short vector units, and other Application Processing Units, e.g., Intel Xeon Phi. Therefore, optimizations and code rewrites are required to target each new architecture. This project will develop two tools to aid in the parallelization of compute applications for SIMD/SIMT architectures. The first tool will perform a dynamic analysis to determine the potential to extract SIMD/SIMT parallelization from an application. The second tool will be a Domain Specific Language (DSL) designed to aid in the SIMDization of control dependent application components. The DSL compiler will automatically generate a SIMD/SIMT optimized code version targeted at the compute architecture of interest (e.g., GPU, SIMD Vector Units like AVX, or Intel Xeon Phi). Initial development and experiments will be developed for Geant4.

Primary U.S. Work Locations and Key Partners
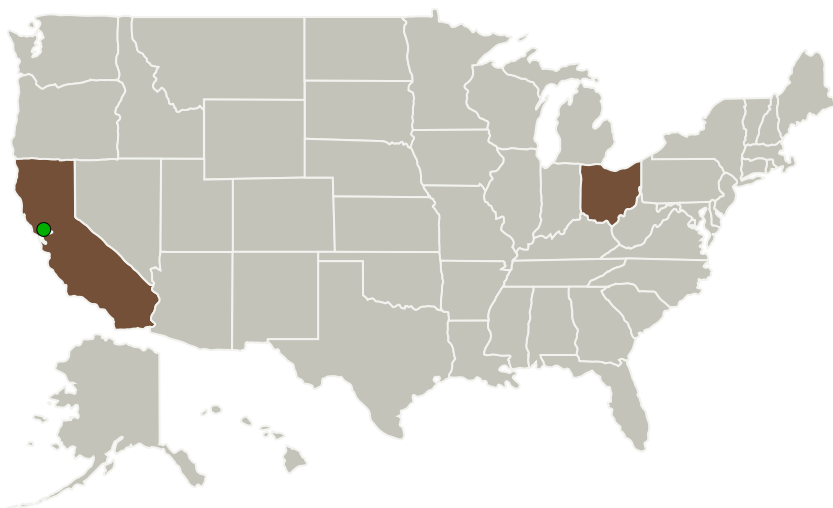
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Organizations Performing Work	Role	Type	Location
RNET Technologies, Inc.	Lead Organization	Industry	Dayton, Ohio
🟢Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations	
California	Ohio

Project Transitions

▶ **June 2014:** Project Start

✔ **December 2014:** Closed out

Closeout Documentation:
- Final Summary Chart*(https://techport.nasa.gov/file/137479)*

Images
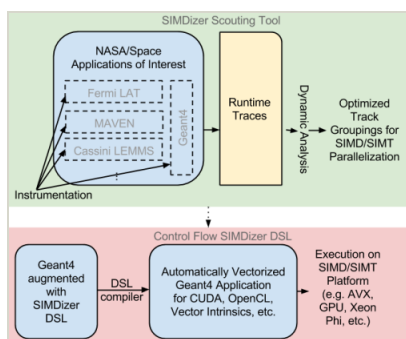
Briefing Chart
Domain Specific Language for Geant4 Parallelization for Space-Based Applications, Phase I
(https://techport.nasa.gov/image/131058)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

RNET Technologies, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:
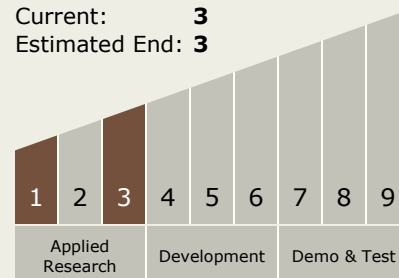
Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Gerald Sabin

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**

1	2	3	4	5	6	7	8	9
Applied Research			Development			Demo & Test		

Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  └ TX11.1 Software Development, Engineering, and Integrity
    └ TX11.1.7 Frameworks, Languages, Tools, and Standards

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System